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Two Updating Schemes of Iterative Learning Control for Networked Control Systems with Random Data Dropouts☆

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Abstract

The iterative learning control (ILC) problem is addressed in this paper for stochastic linear systems with random data dropout modeled by a Bernoulli random variable. Both intermittent updating scheme and successive updating scheme are provided on the basis of the available tracking information only and shown to be convergent to the desired input almost certainly. In the intermittent updating scheme, the algorithm only updates its control signal when data is successfully transmitted. In the successive updating scheme, the algorithm continuously updates its control signal with the latest available data in each iteration whether the output information of the last iteration is successfully transmitted or lost. Illustrative simulations verify the convergence and effectiveness of the proposed algorithms.

Keywords: Iterative Learning Control, Data Dropout, Intermittent Updating Scheme, Successive Updating Scheme, Networked Control System.

1. Introduction

Iterative learning control (ILC) is an important branch of intelligent control, especially for repetitive systems. Since first proposed by Arimoto in 1984 [5], ILC has been developed for three decades and many excellent achievements have been reported [6, 2, 31]. The inherent idea of ILC is to generate the input signal for the current iteration by using the input and output information from previous iterations as well as the desired trajectory. Thus, tracking performance is successively improved along the iteration axis, unlike in the traditional control strategies that improve control performance along the time axis [6]. The system has to complete the given tracking task in a finite time interval and then repeat it again and again because of this operation mechanism. Examples of these systems are chemical processes, robotics, and hard disk drives, to name a few.

Many studies have been conducted on different ILC topics, such as update law design [19], robustness [17, 20, 37], frequency analysis [43], and application research [7, 22, 41]. Moreover, the exploration of ILC has been extend to new problems, such as multi-phase processes [38], varying tasks [44], iteration varying lengths [23, 35, 36], event-triggered control [40], control with quantization information [11, 34], collaborative tracking [16], and initial state vibration [39]. However, most of these studies mainly concern ILC in terms of centralized control systems, the controller and plant of which are placed together, so that each piece of information can be well received and processed. Recently, networked control systems (NCSs) have been widely used because of their facility, flexibility, and robustness with the help of the fast developments of communication and network techniques. In this kind of system implementation, data transmission is a critical topic as data dropouts damage the tracking performance. This situation motivates the research on ILC for NCSs.

Other papers have also focused on ILC for a class of networked systems called multi-agent systems [21, 26, 27, 28]. However, the major difference between these studies and ours is the description of a networked system. In [21, 26, 27, 28], the multi-agent is a networked complex system combined by multiple subsystems, in which a network

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